

## PEER REVIEW HISTORY

BMJ Open publishes all reviews undertaken for accepted manuscripts. Reviewers are asked to complete a checklist review form (<http://bmjopen.bmj.com/site/about/resources/checklist.pdf>) and are provided with free text boxes to elaborate on their assessment. These free text comments are reproduced below.

## ARTICLE DETAILS

<b>TITLE (PROVISIONAL)</b>	Does Performance at the Intercollegiate Membership of the Royal Colleges of Surgeons (MRCS) Examination Vary According to UK Medical School and Course Type? A retrospective cohort study
<b>AUTHORS</b>	Ellis, Ricky; Brennan, Peter; Scrimgeour, Duncan; Lee, Amanda; Cleland, Jennifer

## VERSION 1 – REVIEW

<b>REVIEWER</b>	Barnes, Tracey University of Otago
<b>REVIEW RETURNED</b>	16-Jul-2021

<b>GENERAL COMMENTS</b>	<p>This is an interesting topic and one that warrants investigation and publication to assist people to make decisions that align with their career aspirations i.e. if you know you want to be a surgeon prior to medical school that you can pick the appropriate institution. Given the financial cost to individuals choosing a medical career pathway it could be suggested that they have a right to this information. The article is generally well written but I do have some concerns regarding the methodology that I believe should be addressed prior to publication. I have several more minor suggestions to improve clarity.</p> <p>The abstract is clearly structured and succinct, at points this is possibly better structured than the actual article.</p> <p>Within the article itself your research question is not clearly defined, at the end of the background section instead of an aim or question you state what you have done. I suggest you reword as a research aim/question rather than a retrospective overview.</p> <p>Generally abbreviations should be written in full in the text the first time they are used. You should also avoid the use of regional abbreviations e.g. KCL</p> <p>I have a couple of concerns with your methodology as I do not think that you have accounted for all variables that have an impact on MRCS pass rate. Previous studies have clearly shown a significant increase in pass rate in those on Core Surgical Training compared to those in Foundation Years. I am surprised that you did not include this factor as it could account for some of the differences, including the gender and ethnicity differences i.e. is this a true difference or a reflection of those on the training program? I also wonder why you went to the extent of assessing prior academic performance and graduate-entry etc but did not include the impact of intercalated degrees. Intercalation was</p>
-------------------------	---

	<p>competitive entry at my medical school but equally if you intercalate in anatomy then you will have an advantage when it comes to MRCS.</p> <p>At several points you refer to prior academic achievements as 'high-school performance' but this is actually A-level or Scottish Highers. Whether A-levels are sat in high-school or college varies depending on region within the UK. I suggest for clarity, because high-school has a different meaning within the UK as well as the rest of the world, that you stick with "A-levels or equivalent" throughout.</p> <p>In the first paragraph of the results you provide the mean pass rate twice. I suggest you remove the unnecessary repetition.</p> <p>In the opening to your discussion you state that MRCS is a prerequisite for acceptance onto training. This may now be true but it was not previously and it was not a prerequisite for the whole of the study period.</p> <p>You noted that white males are more likely to be successful at passing their surgical exams and another reason for the lack of gateway students do not choose surgery could be a perception of not "fitting".</p> <p>Most of my comments are minor but I would suggest including or at least discussing the other variables prior to acceptance for publication.</p>
--	---

<b>REVIEWER</b>	Hope, David University of Edinburgh, Medical Education Unit
<b>REVIEW RETURNED</b>	25-Oct-2021

<b>GENERAL COMMENTS</b>	<p>This is an interesting paper on a very important topic. However, I think there are a few things missing.</p> <p>Title/abstract</p> <p>Generally fine, but don't assume readers will understand why an association between undergraduate medical school attainment and postgraduate exam attainment is meaningful. Some people - probably quite a lot of people - regard assessment as abstract and separate to clinical knowledge or patient safety. Spell out, even in the abstract, why we ought to care about the existence/non-existence of such a link. Particularly, I suggest avoiding things like "has not been scrutinised" - that's true for almost everything, so instead say why you should prioritise examining this.</p> <p>Strengths and limitations</p> <p>A lot of readers won't know what UKMED is, so the strengths and limitation should spell out why this is relevant. E.g. "Demonstrates utility of large, national-level databases of medical education information."</p> <p>Again, it isn't clear why including and excluding prior academic attainment is useful here. Something like "Able to evaluate the impact of academic attainment prior to medical school," is more helpful for non-experts.</p>
-------------------------	---

	<p>Introduction</p> <p>This is quite narrowly focused on the UK. The audience of this journal is quite international, and so I think you need more space discussing the global challenges of many medical schools within one regulatory environment.</p> <p>In the second paragraph I don't think you quite sell the universality of this research: we should all be interested in this because if we can identify links between undergraduate performance and postgraduate performance, we can align our curricula and assessments across training. This is relevant to everyone - as it reads it is very focused on benefits only relevant to surgeons.</p> <p>Methods</p> <p>Say, in a sentence, what UKMED is. Say, in a sentence, what MRCS is, and give a reference/link for more information. In particular, information on the typical pass rate would help here (you mention it much later on, but do so at the start).</p> <p>Describe ethical approval; not just whether it was formally granted, but who reviewed it, and how you evaluated the risks yourself. This is important because it gives insight into the diligence done.</p> <p>The methods is generally fine, but there is a serious omission under "markers of prior academic attainment." Not all UK nations use A-levels. Were Scottish qualifications used? Was the bacc used? This is very important.</p> <p>Do include something on power, effect sizes, and give a reference to the statistical techniques used for further reading. Quite a lot of readers won't be familiar with the specific methods and this helps them a lot.</p> <p>Did you consider the effect of multiple comparisons, and if so, how?</p> <p>There's a risk with this approach that people may worry you entered a huge number of variables and then kept in only the ones that looked "interesting." As such it would help to describe briefly, earlier on, why you selected the initial variables, and in the discussion, explicitly note any surprises.</p> <p>Results</p> <p>Given the granularity of the OR analysis, the power of each analysis is presumably quite variable. E.g. comparing rank 4 to rank 16. You will need to address the power issue explicitly, as a lot of people won't fully understand the impact it can have on the model.</p> <p>Some people might argue a multilevel modelling approach might work better here. Did you consider this approach, and if so, why did you reject it?</p> <p>Discussion</p>
--	--

	<p>I think you've undersold the enormous importance of finding many of these associations disappear after adjusting for prior academic attainment. You make quite an issue of it in the discussion, but less so in the introduction. One could take the bleak view that our educational processes have collectively limited impact; the ones who did well in exams at 18 do well on graduate assessment a decade or more later. In fact, given we know that very early school indicators correlate highly with A-level results, the implications are perhaps even more bleak.</p> <p>This is a very sensitive topic, but I don't think you can note this finding in passing, and then just move on. You need to fully explore the implications. You get on to this a little bit in the discussion just before "strengths and limitations" but I'd suggest moving this higher and allude to it in the abstract. Probably the most important bit of your study, to me, is the implication that reducing academic entry requirements for some students may put them at risk of failing later assessment.</p> <p>Secondly, I think you need to consider the substantial risk of multicollinearity in many of these measures. E.g. school prestige, school rank, entry requirements, the demographics - they may all be related. At some point the fact that these might not even be semi-independent needs to be considered.</p> <p>Under limitations, I think you need to note that for inclusion a candidate had to get to the MRCS - which is a pretty successful career given that 90%+ of people who apply to study medicine never get in at all. This does imply some amount of range restriction, but also that the candidates we are looking at are generally capable - which is a point in favour of the assessment systems we currently operate.</p>
--	--

#### VERSION 1 – AUTHOR RESPONSE

<p>Reviewer: 1</p> <p>This is an interesting topic and one that warrants investigation and publication to assist people to make decisions that align with their career aspirations i.e. if you know you want to be a surgeon prior to medical school that you can pick the appropriate institution. Given the financial cost to individuals choosing a medical career pathway it could be suggested that they have a right to this information. The article is generally well written but I do have some concerns regarding the methodology that I believe should be addressed prior to publication. I have several more minor suggestions to improve clarity.</p> <p>The abstract is clearly structured and succinct,</p>	<p>This has now been changed, thank you.</p>
--	--

<p>at points this is possibly better structured than the actual article.</p> <p>Within the article itself your research question is not clearly defined, at the end of the background section instead of an aim or question you state what you have done. I suggest you reword as a research aim/question rather than a retrospective overview.</p>	
<p>Generally abbreviations should be written in full in the text the first time they are used. You should also avoid the use of regional abbreviations e.g. KCL</p>	<p>This has now been corrected, thank you.</p>
<p>I have a couple of concerns with your methodology as I do not think that you have accounted for all variables that have an impact on MRCS pass rate. Previous studies have clearly shown a significant increase in pass rate in those on Core Surgical Training compared to those in Foundation Years. I am surprised that you did not include this factor as it could account for some of the differences, including the gender and ethnicity differences i.e. is this a true difference or a reflection of those on the training program? I also wonder why you went to the extent of assessing prior academic performance and graduate-entry etc but did not include the impact of intercalated degrees. Intercalation was competitive entry at my medical school but equally if you intercalate in anatomy then you will have an advantage when it comes to MRCS.</p>	<p>Thank you for your valid suggestion. Unfortunately, we do not have access to stage of training data for first attempt at the examination to adjust for this. Stage of training could be extrapolated using date of graduation, however, given that approximately ...% of UK doctors take at least one year out of training after the Foundation programme, this would introduce a significant degree of inaccuracy to the analyses. Similarly, we were unable to adjust for intercalation. Those who intercalate are known to perform better in later medical school examinations (Cleland, J. et al. An intercalated BSc degree is associated with higher marks in subsequent medical school examinations. BMC Med Educ 9, 24 (2009). <a href="https://doi.org/10.1186/1472-6920-9-24">https://doi.org/10.1186/1472-6920-9-24</a>), which is likely related to competitive entry to intercalation programmes. It is highly likely that these will continue to be top performers in postgraduate assessments. However, very few intercalating students will be graduates and are therefore unlikely to experience the same burden of time, financial and caring commitments. The impact of intercalating on markers of postgraduate performance across all specialties would be best assessed in a standalone paper. This would be particularly relevant given the recent removal of points scored for undergraduate degrees in UKFPO selection measures which has started debate regarding the future merit of intercalating.</p>
<p>At several points you refer to prior academic achievements as 'high-school performance' but this is actually A-level or Scottish</p>	<p>This has now been clarified in the methods and limitations sections, thank you.</p>

Highers. Whether A-levels are sat in high-school or college varies depending on region within the UK. I suggest for clarity, because high-school has a different meaning within the UK as well as the rest of the world, that you stick with "A-levels or equivalent" throughout.	
In the first paragraph of the results you provide the mean pass rate twice. I suggest you remove the unnecessary repetition.	This has now been corrected.
In the opening to your discussion you state that MRCS is a prerequisite for acceptance onto training. This may now be true but it was not previously and it was not a prerequisite for the whole of the study period.	This has now been clarified.
You noted that white males are more likely to be successful at passing their surgical exams and another reason for the lack of gateway students do not choose surgery could be a perception of not "fitting".	This has now been added, thank you.
<p>Reviewer: 2</p> <p>This is an interesting paper on a very important topic. However, I think there are a few things missing.</p> <p>Title/abstract</p> <p>Generally fine, but don't assume readers will understand why an association between undergraduate medical school attainment and postgraduate exam attainment is meaningful. Some people - probably quite a lot of people - regard assessment as abstract and separate to clinical knowledge or patient safety. Spell out, even in the abstract, why we ought to care about the existence/non-existence of such a link. Particularly, I suggest avoiding things like "has not been scrutinised" - that's true for almost everything, so instead say why you should prioritise examining this.</p>	This has now been clarified, thank you.
<p>Strengths and limitations</p> <p>A lot of readers won't know what UKMED is, so the strengths and limitation should spell out why this is relevant. E.g. "Demonstrates utility of large, national-level databases of medical education information."</p> <p>Again, it isn't clear why including and excluding</p>	This has now been explained in the revised manuscript.

<p>prior academic attainment is useful here. Something like "Able to evaluate the impact of academic attainment prior to medical school," is more helpful for non-experts.</p>	
<p>Introduction</p> <p>This is quite narrowly focused on the UK. The audience of this journal is quite international, and so I think you need more space discussing the global challenges of many medical schools within one regulatory environment.</p> <p>In the second paragraph I don't think you quite sell the universality of this research: we should all be interested in this because if we can identify links between undergraduate performance and postgraduate performance, we can align our curricula and assessments across training. This is relevant to everyone - as it reads it is very focused on benefits only relevant to surgeons.</p>	<p>We have revised the introduction to include the relevance of the study to international readers. We have also discussed relevant studies carried out in the US.</p> <p>We have now explained the importance of this study in aligning curricula and values as suggested.</p>
<p>Methods</p> <p>Say, in a sentence, what UKMED is. Say, in a sentence, what MRCS is, and give a reference/link for more information. In particular, information on the typical pass rate would help here (you mention it much later on, but do so at the start).</p>	<p>These have now been added.</p>
<p>Describe ethical approval; not just whether it was formally granted, but who reviewed it, and how you evaluated the risks yourself. This is important because it gives insight into the diligence done.</p>	<p>The ethics section has been expanded and now contains the standard UKMED ethics response as used in other UKMED studies published in BMJ Open.</p>
<p>The methods is generally fine, but there is a serious omission under "markers of prior academic attainment." Not all UK nations use A-levels. Were Scottish qualifications used? Was the bacc used? This is very important.</p>	<p>This has now been discussed in the limitations section of the manuscript.</p>

Do include something on power, effect sizes, and give a reference to the statistical techniques used for further reading. Quite a lot of readers won't be familiar with the specific methods and this helps them a lot.	A reference on backward regression has been added to the methods section and a comment on power added to the limitations section.
Did you consider the effect of multiple comparisons, and if so, how?	All of the analyses were pre-specified, no post-hoc comparisons were performed. All effect sizes are given with accompanying 95% confidence intervals allowing the reader to assess both statistical and clinical relevance whilst observing the varying number of candidates in each Medical School. Use of adjustment for multiple comparisons is contentious and many statisticians would advise against it, advocating the use of confidence intervals instead. Co-author, Professor Lee who is Chair in Medical Statistics subscribes to this view.
There's a risk with this approach that people may worry you entered a huge number of variables and then kept in only the ones that looked "interesting." As such it would help to describe briefly, earlier on, why you selected the initial variables, and in the discussion, explicitly note any surprises.	The robust method for building the regression models were described in the statistical analysis section of the methods and an appropriate reference added.
<p>Results</p> <p>Given the granularity of the OR analysis, the power of each analysis is presumably quite variable. E.g. comparing rank 4 to rank 16. You will need to address the power issue explicitly, as a lot of people won't fully understand the impact it can have on the model.</p>	This has now been discussed in the strengths and limitations section.
Some people might argue a multilevel modelling approach might work better here. Did you consider this approach, and if so, why did you reject it?	Given that the candidates are nested within medical school, a multilevel approach could be used. However, with the heterogeneity of passing MRCS at first attempt across medical schools, it was decided an individual regression approach would be preferable.
<p>Discussion</p> <p>I think you've undersold the enormous importance of finding many of these associations disappear after adjusting for prior</p>	Thank you for highlighting this. We have now expanded our discussion on prior academic attainment in the introduction and discussion sections and have emphasised the importance of our main findings. Additionally, we have now



<p>academic attainment. You make quite an issue of it in the discussion, but less so in the introduction. One could take the bleak view that our educational processes have collectively limited impact; the ones who did well in exams at 18 do well on graduate assessment a decade or more later. In fact, given we know that very early school indicators correlate highly with A-level results, the implications are perhaps even more bleak.</p> <p>This is a very sensitive topic, but I don't think you can note this finding in passing, and then just move on. You need to fully explore the implications. You get on to this a little bit in the discussion just before "strengths and limitations" but I'd suggest moving this higher and allude to it in the abstract. Probably the most important bit of your study, to me, is the implication that reducing academic entry requirements for some students may put them at risk of failing later assessment.</p>	<p>added a section titled "Implications for practice" to our discussion where we discuss why these important findings are relevant, who they are relevant to and how they may be used.</p>
<p>Secondly, I think you need to consider the substantial risk of multicollinearity in many of these measures. E.g. school prestige, school rank, entry requirements, the demographics - they may all be related. At some point the fact that these might not even be semi-independent needs to be considered.</p>	<p>This has now been discussed in the limitations section.</p>
<p>Under limitations, I think you need to note that for inclusion a candidate had to get to the MRCS - which is a pretty successful career given that 90%+ of people who apply to study medicine never get in at all. This does imply some amount of range restriction, but also that the candidates we are looking at are generally capable - which is a point in favour of the assessment systems we currently operate.</p>	<p>This has now been added to the limitations section including relevant references that have discussed this in greater detail.</p>

## VERSION 2 – REVIEW

<b>REVIEWER</b>	Hope, David University of Edinburgh, Medical Education Unit
<b>REVIEW RETURNED</b>	26-Nov-2021

<b>GENERAL COMMENTS</b>	Thank you for your comprehensive set of revisions. I think you've covered everything I discussed on first submission.
-------------------------	---

## VERSION 2 – AUTHOR RESPONSE

<p>*In your previous response to the comment from Reviewer #1 below, you did not indicate whether any changes were made to the manuscript. If not, it seems like the lack of data for these points should be discussed as limitations of the analysis.</p> <p>"I have a couple of concerns with your methodology as I do not think that you have accounted for all variables that have an impact on MRCS pass rate. Previous studies have clearly shown a significant increase in pass rate in those on Core Surgical Training compared to those in Foundation Years. I am surprised that you did not include this factor as it could account for some of the differences, including the gender and ethnicity differences i.e. is this a true difference or a reflection of those on the training program? I also wonder why you went to the extent of assessing prior academic performance and graduate-entry etc but did not include the impact of intercalated degrees. Intercalation was competitive entry at my medical school but equally if you intercalate in anatomy then you will have an advantage when it comes to MRCS."</p>	<p>This has now been discussed as a limitation of the study in the strengths and limitations section of the discussion, thank you.</p>
<p>*Thank you for revising the article title in response to the previous editorial request. However, the updated title is declamatory (indicating the findings of the study), which is against journal style. Please rephrase further to avoid this, and to bring back the study design description - eg, "Analysis of variation in performance at Membership of the Royal College of Surgeons (MRCS) examinations by medical school and course type: a retrospective longitudinal cohort study of UK medical graduates" (or similar).</p>	<p>This has now been changed to meet the journal style, thank you.</p>

\*Please adjust the fourth bullet point in the 'Strengths and limitations of this study' section so that it consists of one sentence rather than two.

This has now been changed, thank you.